

SECTION 900—MATERIALS DETAILS**SECTION 901—HYDRAULIC CEMENT AND POZZOLANS****901.01 Hydraulic Cement.**

(a) General. At the time cement is incorporated into the work, it shall meet the quality requirements of these specifications.

Cement which has been in storage may be tested prior to use, and if tests show that it does not meet the requirements specified it will be rejected.

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A means for storing and protecting the cement against dampness shall be provided. Cement which has become partially set or which contains lumps or caked cement will be rejected. Cement salvaged from discarded or used sacks shall not be used.

Different kinds or brands of cement, or cement of the same brand from different mills, even if tested and approved, shall not be mixed during use unless permitted, and then only as directed. They shall not be used alternately in any one pour for any structure, unless otherwise permitted.

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(b) Portland Cement. Portland cement shall conform to the requirements of the following cited specifications except as noted.

1. Requirements.

Cement	Specifications
Air-Entraining Portland Blast-Furnace Slag Cement	AASHTO M 240, Type ISA
Air-Entraining Portland Cement	AASHTO M 85, Type IA or IIIA
Air-Entraining Portland-Pozzolan Cement	AASHTO M 240, Type IP-A
Portland Blast-Furnace Slag Cement	AASHTO M 240, Type IS
Portland Cement	AASHTO M 85, Type I, II or III
Portland-Pozzolan Cement	AASHTO M 240, Type IP

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The exceptions to AASHTO M 240 are as follows:

- a. The amount of pozzolan shall be limited to 20±5 percent by weight of the portland-pozzolan cement for the types IP and IP-A.
- b. The pozzolan in the portland-pozzolan cements, types IP and IP-A, shall be in accordance with ASTM C 618, class C or class F with the loss on ignition of the pozzolan limited to a maximum of 3 percent.
- c. The pozzolan in the portland-pozzolan cements, types IP and IP-A, shall be interground with the portland cement clinker.

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2. Acceptance Criteria. Portland cements and blended cements will be accepted based upon the manufacturer's or manufacturer/distributor's documented ability to consistently furnish these materials in accordance with the applicable AASHTO requirements.

a. General Requirements. Cements shall comply with the applicable requirements of 901 and will be accepted by certification from qualified manufacturers or manufacturer/distributor. The manufacturer is defined as the plant producing the cement. A manufacturer or manufacturer/distributor shall become qualified by establishing a history of satisfactory quality control of cement produced as evidenced by results of tests performed by a testing laboratory which is regularly inspected by the Cement and Concrete Reference Laboratory of the National Institute of Standards and Technology. Proof of such inspection shall be furnished upon request. All certifications shall be prepared by the manufacturer or distributor in accordance with the applicable requirements of 916. If a manufacturer or distributor elects to supply portland cement with a high sulfur trioxide content in accordance with footnote B from Table 1 in AASHTO M 85, it shall supply all of the required supporting data to the Materials and Tests Division prior to supplying such cement. A list of qualified manufacturers and manufacturer/distributors will be maintained by the Department.

The manufacturer or manufacturer/distributor shall conduct sufficient tests to ensure that adequate quality control is maintained and that cement furnished is in accordance with the specification requirements. Documentation pertaining to cement shipped on certification shall be maintained for a period of at least 3 years and shall be provided when requested.

Random samples of cement will be obtained at the concrete plant. If the sample is not in accordance with the specification requirements, an investigation will be conducted. A copy of the findings and conclusions resulting from the investigation will be furnished to the Contractor. Unless the investigation finds the Department is responsible for the failure to comply, the cost of the investigation plus any required corrective action will be assessed to the Contractor.

b. Requirements for Domestic Source Qualification. Cement manufacturers requesting to be qualified to supply cement shall provide the following:

- (1) For the initial qualification, the manufacturer shall provide to the Materials and Tests Division an outline of their quality control procedure including the location and type of samples taken, and a monthly summary of mill test data for the previous years production. A current Material Safety Data Sheet shall be submitted as an integral part of the initial qualification package.
- (2) To maintain qualification, a monthly average of mill test data shall be submitted to the Materials and Tests Division. If a specific type of cement is not manufactured in a given month, the monthly submittal shall state "No type _____ cement was manufactured during the month of _____ 19____".

c. Requirements for Foreign Source Qualification. Foreign cement manufacturers or their domestic distributors requesting to be qualified to supply cement shall

provide the following:

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- (1) For the initial qualifications, the manufacturer and distributor shall provide to the Materials and Tests Division an outline of their quality control procedures including the location and type of samples taken, and a summary of complete test results from the proposed cement source. A current Material Safety Data Sheet shall be submitted as an integral part of the initial qualification package. The quality control procedure must explain the linkage between the cement being furnished and the manufacturer's/distributor's quality control data, relative to ship-loads, barge-loads, railroad car-loads, etc.
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- (2) Once the initial qualifications have been met, the manufacturer or distributor shall be required to furnish the cement test results for each shipment prior to Department cement usage for the first five cement shipments, which are intended for Department use. The test results for all five of these cement shipments must fully comply with the required material specifications. If not, this requirement will be continued for subsequent cement shipments until five consecutive cement shipment test results fully comply with the required material specifications, or Department source approval is withdrawn due to the inability to consistently supply satisfactory cement.
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- (3) To maintain qualification after compliance with the previous requirements, a monthly submission of all cement shipment test results for cement which is intended for Department usage shall be submitted to the Materials and Tests Division. If no cement shipments are received during a given month, the monthly submittal shall state "No cement was received during the month of _____, 19____."

d. Certification. Only qualified manufacturers and manufacturer/distributors as identified by the Department's list of qualified manufacturers and manufacturer/distributors may furnish cement on certification.

A sample certification form addressing all of the required information is included in 916.03(f). Alternate procedures and forms will be considered when requested, and will be approved if there is a positive link between the cement furnished and the manufacturer's quality control data. The additional information required by 903.01(b)1b shall be addressed for portland pozzolan cement.

(c) Masonry Cement. Masonry cement shall be in accordance with ASTM C 91, except the air content test and the water retention test may be waived.

901.02 Fly Ash Used as a Pozzolan.

(a) General. Fly ash is the finely divided residue that results from the combustion of ground or powdered coal. In general, class F fly ash is produced from burning anthracite or bituminous coal and class C fly ash is produced from burning lignite or subbituminous coal.

Fly ash will be accepted from one of the sources on the Department's list of approved fly ash and ground granulated blast furnace slag sources. Fly ash from different sources or different types of fly ash shall not be mixed or used alternately in the same construction unless authorized in writing. Fly ash will be subject to random assurance sampling and testing by the Department. Failure of these random samples to meet the specified requirements will be cause for suspension of the fly ash source approval.

(b) Acceptance Criteria. Acceptance is based upon the supplier's documented ability to consistently furnish material in accordance with the specified requirements.

1. Requirements. The fly ash shall be in accordance with AASHTO M 295 for class C or class F, with the following exceptions:

Loss on Ignition (LOI), Maximum %	3
Autoclave Expansion or Contraction, Maximum %	0.5
Fineness: Amount retained when wet-sieved on 45 μ m sieve, (No. 325) Maximum %	30

On days when fly ash is being accumulated for use as a pozzolan, the supplier shall obtain a minimum of one sample per day and furnish test results for moisture content, loss on ignition, sulfur trioxide and 45 μ m (No. 325) sieve residue for each sample. A specific gravity determination shall be performed on at least one sample per week.

For each 1800 Mg (2,000 tons) produced, a complete AASHTO M 295 analysis shall be performed on a sample composited randomly from the daily samples. The method of randomization shall be subject to approval by the Department.

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2. Test and Calibration Procedure. The testing procedures followed shall be in accordance with ASTM C 311 or other methods approved in writing by the Department.

The minimum frequency for calibration of test equipment is:

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- a. The 45 μ m (No. 325) sieve shall be calibrated every 100 determinations or every 6 months, whichever comes first.
- b. The muffle furnace used for LOI determinations shall have a newly installed thermocouple every 6 months.
- c. The analytical balances and scales shall be calibrated each year.
- d. The concrete compression machine shall be calibrated annually.
- e. The Blaine apparatus shall be calibrated annually.
- f. All instrumentation used for rapid chemical analysis shall comply with applicable requirements of ASTM C 114 using NIST Fly Ash reference materials.

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3. Documentation. Fly ash suppliers requesting approval shall supply the following:

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- a. For the initial approval, a current Materials Safety Data Sheet and a summary of results for all specified tests for 6 consecutive months shall be submitted. No test results shall be more than one year old at the time of request.
- b. To maintain approval, a summary of results for all specified tests shall be submitted monthly. The results of the daily tests shall be available by telephone during normal working hours.
- c. The fly ash suppliers shall furnish a quality control program which ensures the Department of a continuous supply of fly ash complying with the requirements. This program will be reviewed to determine its adequacy.
- d. Certification:

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- (1) For Source Approval, the supplier shall furnish a certification indicating the class of fly ash, the name, location, and unit of the generating plant. It shall state that all fly ash shipped for use on Department projects will be produced under appropriate quality control and shall be in accordance with the specified requirements. It shall further

indicate that the power company will participate in appropriate inspection and assurance testing. A sample certification form is set out in 916.03(e).

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- (2) For certification of test reports, the test results generated in accordance with 901.02(b)1 shall be summarized and submitted monthly. The reports shall state the name and location of the testing facility, and shall be signed by the chemist or technical manager. This certification shall also identify the concrete plants receiving fly ash represented by these results.

901.03 Ground Granulated Blast Furnace Slag Used as a Pozzolan.

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(a) General. Blast furnace slag shall consist of the nonmetallic product, consisting essentially of silicates and aluminosilicates of calcium and other bases, that is developed in a molten condition simultaneously with iron in a blast furnace. A glassy granular material is formed when molten blast-furnace slag is rapidly chilled by immersion in water. This material is then ground to cement fineness, producing ground granulated blast furnace slag.

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Ground granulated blast furnace slag will be accepted from one of the sources on the Department's list of approved fly ash and ground granulated blast furnace slag sources. Ground granulated blast furnace slag from different sources or different grades of ground granulated blast furnace slag shall not be mixed or used alternately in the same construction unless approved in writing. Ground granulated blast furnace slag will be subject to random assurance sampling and testing by the Department. Failure of these random samples to be in accordance with the specified requirements will be cause for suspension of ground granulated blast furnace slag source approval.

(b) Acceptance Criteria. Ground granulated blast furnace slag will be accepted based on the manufacturer's or manufacturer/distributor's documented ability to consistently furnish these materials in accordance with the applicable ASTM and AASHTO requirements.

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1. Requirements. The ground granulated blast furnace slag shall be in accordance with ASTM C 989 for grade 100 or 120.

For each 1800 Mg (2,000 tons) produced, a complete ASTM C 989 analysis shall be performed on a sample composited randomly from the daily samples. The method of randomization shall be subject to approval by the Department.

2. Test and Calibration Procedure. The testing procedures followed shall be in accordance with ASTM C 989 or other methods approved in writing by the Department.

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The minimum frequency for calibration of test equipment is:

- a. The 45 μm (No. 325) sieve shall be calibrated every 100 determinations or every 6 months, whichever comes first.
- b. The analytical balances and scales shall be calibrated each year.

c. The concrete compression machine shall be calibrated annually.

d. The Blaine apparatus shall be calibrated annually.

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e. All instrumentation used for rapid chemical analysis shall be in accordance with the applicable requirements of ASTM C 114 using NIST reference materials.

3. Documentation. Ground granulated blast furnace slag suppliers requesting approval shall supply the following:

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a. For the initial approval, a current Materials Safety Data Sheet and a summary of results for all specified tests for six consecutive months shall be submitted. No test results shall be more than one year old at the time of request.

b. To maintain approval, a summary of results for all specified tests shall be submitted monthly. The results of the daily tests shall be available by telephone during normal working hours.

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c. The ground granulated blast furnace slag suppliers shall furnish a quality control program which ensures the Department of a continuous supply of ground granulated blast furnace slag which is in accordance with the requirements. This program will be reviewed to determine its adequacy.

d. Certification:

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(1) For Source Approval, the supplier shall furnish a certification indicating the grade of ground granulated blast furnace slag, the name, location, and type of manufacturing facility. It shall state that the ground granulated blast furnace slag shipped for use on Department projects will be produced under appropriate quality control and shall be in accordance with the specified requirements. A sample certification form addressing all of the required information is included in 916.03(m).

(2) For certification of test reports, the test results generated in accordance with 901.03(b) shall be summarized and submitted monthly. The reports shall state the name and location of the testing facility, and shall be signed by the chemist or technical manager. This certification shall also identify the concrete plants receiving ground granulated blast furnace slag represented by these results.

SECTION 902—BITUMINOUS MATERIALS

902.01 Asphalt Cements. Asphalt cements shall be in accordance with the following requirements.

(a) Petroleum Asphalt Cements. Petroleum asphalt cements shall be

homogeneous free from water, and shall not foam when heated to 175p C (347p F). Methods of sampling and testing shall be in accordance with applicable provisions of 902.09. The grade used shall be in accordance with the applicable requirements of 902.01(b), 902.01(g), and 902.01(h).

(b) Penetration Graded Petroleum Asphalt Cements. Penetration graded petroleum asphalts shall be in accordance with the following table:

REQUIREMENTS FOR PENETRATION GRADED PETROLEUM ASPHALT CEMENT

GRADE	AP-6 ⁽²⁾	AP-5 ⁽²⁾	AP-4 ⁽²⁾	AP-3 ⁽²⁾	AP-2 ⁽²⁾	AP-1 ⁽²⁾	AP-0 ⁽²⁾
Physical Properties of Original Material:							
Penetration, 25pC, 100 g, 5 sec - (0.1 mm)	50-60	60-70	70-85	85-100	100-120	120-150	150-200
Solubility in Organic Solvents, percent, minimum ⁽¹⁾	99.0	99.0	99.0	99.0	99.0	99.0	99.0
Flash Point, Cleveland Open Cup, pC, minimum ⁽¹⁾	204	204	204	204	204	204	204
Physical Properties of Residue From Thin-Film Oven Test:							
Penetration, 25p C, 100 g, 5 sec - (0.1 mm) minimum ⁽¹⁾	28	32	36	42	48	55	64
Ductility, 25p C, 50 mm per minute, - (10 mm), minimum ⁽¹⁾	30	40	50	60	70	90	100

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- (1) Test will be performed when complete physical characteristics are needed or desired.
- (2) The maximum temperature at time of use shall be as specified in 902.10.

(c) **Blank.**

(d) **Blank.**

(e) **Blank.**

(f) **Blank.**

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(g) **Viscosity Graded Petroleum Asphalt Cements.** Viscosity graded asphalt cements shall be in accordance with AASHTO M 226, and the following table:

**REQUIREMENTS FOR VISCOSITY GRADED PETROLEUM
ASPHALT CEMENTS**

GRADE	AC 2.5 ⁽²⁾	AC-5 ⁽²⁾	AC-10 ⁽²⁾	AC-15 ⁽²⁾	AC-20 ⁽²⁾
Physical Properties of Original Material:					
Absolute Viscosity, 60p C, 300 mm Hg vacuum, poises	200 to 315	400 to 625	800 to 1250	1200 to 1875	1600 to 2500
Kinematic Viscosity, 135p C, Centistokes, minimum ⁽¹⁾	125	175	250	275	300
Penetration 25p C, 100 g, 5 sec, - (0.1 mm)	180	100	70	60	50
Flash Point, Cleveland Open Cup, pC, minimum ⁽¹⁾	163	177	218	227	232
Solubility in organic solvents, %, minimum ⁽¹⁾	99.0	99.0	99.0	99.0	99.0
Physical Properties of Residue From Thin-Film Oven Test:					
Ductility, 25p C, 50 mm per minute - (10 mm), minimum ⁽¹⁾	100	90	60	50	40
Absolute Vis, 60p C, 300 mm Hg vacuum, poises, maximum ⁽¹⁾	1000	2000	4000	6000	8000

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- (1) Test will be performed when complete physical characteristics are needed or desired.
- (2) The maximum temperature at time of use shall be in accordance with 902.10.

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(h) **Performance Graded Petroleum Asphalt Cements.** Performance graded asphalt cements shall be in accordance with AASHTO MP1 and the following table:

**REQUIREMENTS FOR PERFORMANCE GRADED PETROLEUM
ASPHALT CEMENTS**

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GRADE	PG 52-22	PG 58-22	PG 58-28	PG 64-22
ORIGINAL BINDER				
Flash Point, pC , minimum	230	230	230	230
Viscosity, maximum, 3 Pa-s, Test Temp., pC	135	135	135	135
Dynamic Shear, $G^*/\sin \delta$, minimum, 1.00 kPa, Test Temp. @ 10 rad/s, pC	52	58	58	64
ROLLING THIN FILM OVEN RESIDUE				
Mass Loss, Maximum, %	1.00	1.00	1.00	1.00
Dynamic Shear, $G^*/\sin \delta$, minimum, 2.20 kPa, Test Temp. @ 10 rad/s, pC	52	58	58	64
PRESSURE AGING VESSEL (PAV) RESIDUE				
PAV Aging Temperature, pC	90	100	100	100
Dynamic Shear, $G^*/\sin \delta$, minimum, 5000 kPa, Test Temp. @ 10 rad/s, pC	19	22	19	25
Physical Hardening ⁽¹⁾	Report	Report	Report	Report
Creep Stiffness, S, maximum, 300 MPa, m value, minimum, 0.300. Test Temp. @ 60 s, pC	-12	-12	-18	-12

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- (1) Physical Hardening is performed on a set of asphalt beams according to AASHTO TP1 Section 13.1, except the conditioning time is extended to 24 hrs. \pm 10 minutes at 10 pC above the minimum performance temperature. The 24-hour stiffness and m-value are reported for information purposes only.

902.02 Blank.

902.03 Cutback Asphalts. Cutback asphalts shall be composed of an intimate homogeneous mixture of an asphalt base and a suitable distillate designed for rapid, medium, or slow curing. Cutback asphalts may also contain an additive as an aid in uniformly coating wet, damp, or dry aggregates used in patching mixtures or bituminous

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pavements. These asphalts shall not contain more than 0.5 percent water as determined by AASHTO T 55, shall not separate when allowed to stand, and shall not foam when heated to permissible temperatures. When an additive is used, it shall be incorporated homogeneously in the asphalt at the point of manufacture. Methods of sampling and testing shall be in accordance with the applicable provisions of 902.09. The grade used shall be in accordance with the applicable requirements of 902.03(a), 902.03(b), and 902.03(c). At no time shall the temperature of the asphalt be higher than shown for that grade in 902.10.

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(a) Rapid Curing Asphalts With and Without Additive. Rapid curing asphalts with and without additive shall be in accordance with the following table:

**REQUIREMENTS FOR RAPID CURING ASPHALTS WITH
AND WITHOUT ADDITIVE**

Characteristics	Grades			
	RC-70 RCA-70	RC-250 RCA-250	RC-800 RCA-800	RC-3000 RCA-3000
Flash Point (Open Tag.), (pC), minimum	----	27	27	27
Kinematic Viscosity at 60p C (cs.) ⁽²⁾	70-140(3)	250-500	800-1600	3000-6000
Saybolt-Furol Viscosity at 50p C (Sec.)	60-120	----	----	----
Saybolt-Furol Viscosity at 60p C (Sec.)	----	125-250	----	----
Saybolt-Furol Viscosity at 82p C (Sec.)	----	----	100-200	300-600
Distillation ⁽¹⁾				
Distillate (% of total distillate to 360p C):				
to 190p C	10+	---	---	----
to 225p C	50+	35+	15+	----
to 260p C	70+	60+	45+	25+
to 316p C	85+	80+	75+	70+
Residue from distillation to 360p C (volume % by difference)	55+	65+	75+	80+
Tests on Residue from Distillation: ⁽¹⁾				
Penetration, 25p C, 100 g, 5 sec (0.1 mm) (with additive)	80-160	80-160	80-160	80-160
(without additive)	80-120	80-120	80-120	80-120
Ductility, 25p C (10 mm)	100+	100+	100+	100+
Solubility in organic solvents (%)	99.5+	99.5+	99.5+	99.5+

120

- (1) Test may be waived when approved.
- (2) Viscosity may be determined by either the Saybolt-Furol or Kinematic test. In case of dispute, the Kinematic viscosity test shall prevail.
- (3) May be 70-500 when used as Tack Coat and sampled from contractors storage.

(b) Medium Curing Asphalts With and Without Additive. Medium curing asphalts with and without additive shall be in accordance with the following table:

**REQUIREMENTS FOR MEDIUM CURING ASPHALTS WITH
AND WITHOUT ADDITIVE**

Characteristics	Grades			
	MC-70 MCA-70	MC-250 MCA-250	MC-800 MCA-800	MC-3000 MCA-3000
Flash Point (Open Tag.), $^{\circ}\text{C}^{(4)}$	38+	66+	66+	66+
Kinematic Viscosity at 60 $^{\circ}\text{C}$ (cs.) ⁽²⁾	70-140(3)	250-500	800-1600	3000-6000
Saybolt-Furol Viscosity at 50 $^{\circ}\text{C}$ (Sec.)	60-120	----	----	----
Saybolt-Furol Viscosity at 60 $^{\circ}\text{C}$ (Sec.)	----	125-250	----	----
Saybolt-Furol Viscosity at 83 $^{\circ}\text{C}$ (Sec.)	----	----	100-200	300-600
Distillation ⁽¹⁾ Distillate (% of total distillate to 360 $^{\circ}\text{C}$ MC-70 @ 225): to 225 $^{\circ}\text{C}$ to 260 $^{\circ}\text{C}$ to 316 $^{\circ}\text{C}$ Residue from distillation to 360 $^{\circ}\text{C}$ (volume % by difference)	0-20 20-60 65-90 55+	0-10 15-55 60-87 67+	---- 35+ 45-80 75+	---- 15+ 15-75 80+
Tests on Residue from Distillation: ⁽¹⁾ Penetration, 25 $^{\circ}\text{C}$, 100 g., 5 sec - (0.1mm) (without additive) (with additive) Ductility, 25 $^{\circ}\text{C}$ (10 mm) ⁽³⁾ Solubility in organic solvents (%)	120-250 120-300 100+ 99.5+	120-250 120-300 100+ 99.5+	120-250 120-300 100+ 99.5+	120-250 120-300 100+ 99.5+

(1) Test may be waived when approved.

(2) Viscosity may be determined by either the Saybolt-Furol or Kinematic test. In case of dispute, the Kinematic viscosity test shall prevail.

(3) If the ductility at 25 $^{\circ}\text{C}$ is less than 100, the material will be acceptable if its ductility at 16 $^{\circ}\text{C}$ is 100+.

(4) Flash point by Cleveland Open Cup may be used for products having a flash point greater than 80 $^{\circ}\text{C}$.

(c) **Slow Curing Asphalts With and Without Additive.** Slow curing asphalts with and without additive shall be in accordance with the following table:

160

**REQUIREMENTS FOR SLOW CURING ASPHALTS WITH
AND WITHOUT ADDITIVE**

Characteristics	Grades			
	SC-70 SCA-70	SC-250 SCA-250	SC-800 SCA-800	SC-3000 SCA-3000
Flash Point (Cleveland Open Cup), (°C)	66+	79+	93+	107+
Kinematic Viscosity at 60° C (cSt) ⁽²⁾	70-140	250-500	800-1600	3000-6000
Saybolt-Furol Viscosity at 50° C (Sec.)	60-120	----	----	----
Saybolt-Furol Viscosity at 60° C (Sec.)	----	125-250	----	----
Saybolt-Furol Viscosity at 83° C (Sec.)	----	----	100-200	300-600
Distillation ⁽¹⁾				
Total Distillate to 360° C (% by volume)	10-30	4-20	2-12	5
Float Test of Distillation Residue at 50° C (sec)	20-100	25-110	50-140	75-200
Ductility of Asphalt Residue at 25° C (10 mm) ⁽¹⁾	100+	100+	100+	100+
Solubility in organic solvents (%) ⁽¹⁾	99.5+	99.5+	99.5+	99.5+

170

(1) Test may be waived when approved.

(2) Viscosity may be determined by either the Saybolt-Furol or Kinematic test. In case of dispute, the Kinematic viscosity test shall prevail.

180

902.04 Asphalt Emulsions. Asphalt emulsions shall be composed of an intimate homogeneous suspension of a base asphalt, an emulsifying agent, and water. Asphalt emulsions may contain additives to improve handling and performance characteristics. Failure of an emulsion to perform satisfactorily in the field shall be cause for rejection, even though it passes laboratory tests. The grade used shall meet the requirements for that grade in accordance with the table for asphalt emulsions as shown herein. Methods of sampling and testing shall be in accordance with the applicable provisions of 902.09.

AE-60 is a medium-breaking, low-penetration, high-asphalt content type, intended for hot plant mixing, or as otherwise specified.

AE-90 is a medium-breaking, moderate penetration, high-asphalt content type, intended for hot and cold plant mixing, road mixing, and seal coats or as otherwise specified.

190

AE-150 is a medium-breaking, moderately soft penetration type, intended for use in surface treating, tack coats, and coating open and densegraded aggregate, or as otherwise specified.

AE-150-L is a medium-breaking, relatively low-viscosity type. It may be specified in lieu of AE-T or AE-150 when a softer asphalt or greater aggregate penetration is desired. AE-150-L is suitable for sand seals.

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AE-300 is a medium-breaking type, intended for mixing with densegraded aggregate for winter stockpiling.

AE-P is a medium-breaking, very soft asphalt, high-asphalt content type, intended for priming surfaces where penetration of aggregate is required or some softening of existing bituminous surfaces is desirable.

AE-PL is a medium-slow-breaking, low-viscosity, low-asphalt content type, intended for use as a prime or as a dust palative.

210

AE-T is a medium-breaking, comparatively low penetration type, intended for tack coats, seed mulching, or as otherwise specified.

HFRS-2 is a quick-breaking, high-viscosity, high-float, relatively high asphalt content type, intended for seal coats.

RS-2 is a quick-breaking, high-viscosity, relatively high-asphalt content type, intended for seal coats.

The requirements for asphalt emulsions are included in the following table:

REQUIREMENTS FOR ASPHALT EMULSIONS

Characteristics ⁽¹¹⁾	Grade	RS-2 ⁽²⁾	HFRS-2 ⁽²⁾	AE-60 ⁽¹⁾	AE-90 ⁽²⁾	AE-T ⁽²⁾	AE-150 ⁽²⁾	AE-150L ⁽²⁾	AE-300 ⁽²⁾	AE-P ⁽²⁾	AE-PL ⁽²⁾⁽⁸⁾
Saybolt-Furol Viscosity, 25p C, sec	min. max.				50	100	50	100	50		115
Saybolt-Furol Viscosity, 50p C, sec		75-400	75-400				⁽⁹⁾			15-150	
Residue from Res. by Dist., %	min. max.	68	68	68	68	54 62	68	60 65	65 ⁽¹⁰⁾	65	30
Oil Portion, from Res. by Dist. ml oil per 100 g, Emul., max. ⁽³⁾		4.0	4.0	2.0	4.0	4.0	7.0	7.0	7.0 ⁽¹⁰⁾	25.0	3.0
Settlement, 5 days, %, max. ⁽⁴⁾		5	5	5	5						
Stone Coating Test ⁽⁵⁾					⁽⁵⁾		⁽⁶⁾	⁽⁶⁾	⁽⁶⁾		
Demulsibility, %, minimum ⁽⁷⁾	35 ml 0.02N CaCl ₂ 50 ml 0.10N CaCl ₂	50	50	75	75	75					
Sieve Test, % max. ⁽¹²⁾		0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Res. by Dist. Float Test ⁽⁷⁾	at 50p, sec max. at 60p C, sec min.		1200	1200	1200	1200	1200	1200	1200	200	
Penetration ⁽⁷⁾ (0.1 mm)	2p C, 100 g, 5 sec 25p C, 50 g, 5 sec	100-200	100-200	50-100	100- 200	50-200	100-300	100-300	300+		
Solubility in Org. Solv., %, Min. ⁽⁷⁾		97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5
Ductility, 2p C, cm minimum ⁽⁷⁾		40	40	40	40	40					

NOTES: (1) Emulsified asphalt shall be readily pumpable under field conditions. Material may be rejected if Saybolt-Furol viscosity at 50p C exceeds 500 sec. (2) Emulsified asphalt shall be readily sprayable under field conditions. (3) The oil distillate shall be in accordance with ASTM D 396 table 1 Grade 1. (4) This requirement is waived if the emulsion is used within 5 days. (5) See test (u)3a in 902.09. (6) See test (u)3b in 902.09. (7) The test may be waived by the Engineer. (8) See test (y) in 902.09. (9) AE-150 to be used for crackfilling shall have Saybolt-Furol viscosity from 75 to 300 sec. at 50p C during the period November through March. (10) The combined percentages of the residue portion, and of the oil portion from the residue by distillation test shall be 70.0%, minimum. (11) The Engineer will determine the feasibility of performing tests on samples that are broken or more than 10 days old. (12) A maximum of 0.30% is acceptable for samples taken at the point of use provided the material remains sprayable.

902.05 Blank.

902.06 Utility Asphalt. The asphalts shall be prepared by the refining of petroleum. They shall be uniform in character and shall not foam when heated to 177° C (351° F). Utility asphalts shall be in accordance with the following table:

260

REQUIREMENTS FOR UTILITY ASPHALTS

Characteristics\Grades	UA-I	UA-II	UA-III
Softening Point (Ring & Ball), °C	46-63	63-85	79.5-96
Penetration of Original Samples ⁽¹⁾ (0.1 mm) At 4° C, 200 g, 60 sec Min. at 25° C, 100 g, 5 sec at 46° C, 50 g, 5 sec	10 50-100 100 min.	10 25-45 130 max.	10 15-35 90 max.
Ductility @ 25° C, 50 mm per min, 10 mm, Min. ⁽¹⁾	30	10	2.5
Solubility in Organic Solvents, percent, Min. ⁽¹⁾	99.0	99.0	99.0
Flash Point (Cleveland Open Cup), °C, Min. ⁽¹⁾	225	225	225
Penetration of Residue from Thin Film Oven Test, 25° C, 100 g, 5 sec, (0.1 mm) minimum ⁽¹⁾	30	15	10

(1) Test will be performed when complete physical characteristics are needed or desired.

270

(a) Asphalt for Waterproofing. Utility asphalt grade UA-I and asphalt cement grades AP-3, AP-4, AP-5, and AC-20 may be used, provided satisfactory results are obtained.

(b) Asphalt for Undersealing Cement Concrete Pavement. Utility asphalt grades UA-II or UA-III may be used.

902.07 Asphalt for Coating Corrugated Metal Pipe. Asphalt for coating corrugated metal pipe shall be in accordance with the following table:

280

**REQUIREMENTS FOR ASPHALT FOR COATING
CORRUGATED METAL PIPE**

Physical Properties	Minimum	Maximum
Softening Point (Ring & Ball), °C	93	110
Penetration of Original Samples (0.1 mm) 4° C, 200 g, 60 sec Min. At 25° C, 100 g, 5 sec	20 35 ⁽¹⁾	
Solubility in Organic Solvents, %	99.0	
Flash Point (Cleveland Open Cup), °C	232	
Flow Test, mm		6.4
Shock Test	3 of 4 Specimens shall pass	

(1) May be 30 minimum provided all 4 shock test specimens pass.

902.08 Blank.

902.09 Sampling and Testing Bituminous Materials. References to test methods, unless otherwise noted, are to AASHTO as set out in 106.02. The tests and AASHTO reference are as follows:

- 300** (a) Sampling Bituminous Materials AASHTO T 40
(The following exceptions to AASHTO T 40 shall apply)

1. Samples may be obtained at any time before material is incorporated into the work.
2. Samples for all grades of Asphalt Emulsion shall be a minimum of 1.9 L (1/2 gal.). The size of samples of other liquid material may be 1.0 L (1 qt).
3. Samples of liquid materials shall be obtained as follows:

- 310**
- a. Bulk storage tanks from approved sampling valves located in the tank or line and bituminous plant storage tanks from approved sampling valves located in the tank
 - b. Transports from approved sampling valves
 - c. Distributors from approved sampling valves
 - d. Other storage or locations as approved

e. Sampling by other recognized devices may be approved

(b) Water in petroleum products, except the solvent
or carrier may be toluene AASHTO T 55

(c) Density, Specific Gravity, or API Gravity of
Crude Petroleum and Liquid Products by
Hydrometer Method AASHTO T 227

330

(d) Specific Gravity of Semi-Solid Bituminous
Materials AASHTO T 228

(e) Specific Gravity of Solid Pitch and Asphalt AASHTO T 229

(f) Flash and Fire Points (Open Cup)

1. When the flash point is higher than 79p C
(175p F), "Flash and Fire Points by
Cleveland Open Cup" AASHTO T 48

340

2. When the flash point is 79p C (175p F)
or lower, "Flash Point with Tagliabue
Open Cup" AASHTO T 79

(g) Softening Point of Bituminous Materials,
Ring and Ball AASHTO T 53

(h) Penetration of Bituminous Materials AASHTO T 49

350

(i) Loss on Heating AASHTO T 47

(j) Blank

(k) Solubility in Organic Solvents, except the
solvent may be 1,1,1,-Trichloroethane AASHTO T 44

(l) Inorganic Matter or Ash AASHTO T 59

(m) Saybolt-Furol Viscosity AASHTO T 72

360

(n) Ductility of Bituminous Material, except that the conditioning period of
the specimens may be shortened, and that only one normal test will be
required. Shortened conditioning period: The specimen shall be allowed
to cool in air for at least 30 minutes. It shall then be trimmed and placed
in the water bath for a period of 60 to 90 minutes before testing. In case
of failure or dispute, 3 normal tests will be required and specimens shall
be conditioned as in AASHTO T 51 AASHTO T 51

- 370** (o) Distillation of Cutback Asphaltic Products, except
the length of condenser tube may
be 400 mm \pm 24 mm AASHTO T 78
- (p) Float Test for Bituminous Materials AASHTO T 50
- (q) Kinematic Viscosity of Asphalts AASHTO T 201
- (r) Absolute Viscosity of Asphalts AASHTO T 202
- 380** (s) Effect of Heat and Air on Asphalt Materials,
Thin-Film Oven Test AASHTO T 179
- (t) Effect of Heat and Air on a Moving Film of
Asphalt, Rolling Thin Film Oven Test AASHTO T 240
- (u) Testing Asphalt Emulsions AASHTO T 59

The following exceptions to T 59 shall apply:

- 390** 1. For the Residue by Distillation test, the specified aluminum alloy still shall
be the referee still.
2. When tests on the residue are not required, the percent of residue for
Emulsion grades RS-2, AE-60, AE-90, and AE-T only, may be determined
by the Residue by Evaporation test of AASHTO T 59. The percent of
residue shall be determined by the Residue of Distillation test in all cases of
failure or dispute.
- 400** 3. The stone coating test shall be performed as follows on a mixture of 465 \pm
1 grams of reference stone and 35.0 \pm 0.1 grams of Asphalt Emulsion:
- a. For AE-90 the mixture of stone and asphalt shall be mixed vigorously for
5 minutes. At the end of the mixing period, the mix shall be rinsed by
running sufficient tap water at the side of the container to completely
immerse the mix. The tap water shall then be poured off and the rinsing
step repeated as necessary until the rinse water pours off essentially
clear. The stone shall remain a minimum of 90 percent coated.
- 410** b. For AE-150, AE-150-L, and AE-300, the mixture of stone and asphalt
shall be mixed vigorously for 5 minutes and then allowed to stand for 3
hours. At the end of this time, the mixture shall again be mixed
vigorously for 5 minutes. At the end of the mixing period, the mix shall
be rinsed by running sufficient tap water at the side of the container to
completely immerse the mix. The tap water shall then be poured off and
the rinsing step repeated as necessary until the

rinse water pours off essentially clear. The stone shall remain a minimum of 90 percent coated for AE-150, AE 150-L, and AE-300.

420

4. For the Demulsibility test, normally only one test will be required. In case of failure or dispute, the specified procedure in AASHTO T 59 will be followed.

5. For oil portion from Residue by Distillation, report the number of milliliters of oil per 100 grams of emulsion.

(v) Blank.

430

- (w) For coating test for cutback asphalts with additive, 20 grams of 20 to 30 mesh Ottawa sand shall be placed in a clean 60 mL (2 oz) wide-mouthed jar and covered with 25 grams of distilled water at room temperature. One gram of the liquid asphalt to be tested shall be placed gently upon the surface of the water so that it floats and does not contact the sand. The lid shall then be placed on the jar and tightened securely. If the liquid asphalt to be tested is grade 70 or 250, the jar and contents shall be shaken vigorously for 30 seconds. If the grade is 800 or 3000, the jar and contents shall be immersed in a 46° C (115° F) water bath for 5 minutes to bring the contents of the jar to a temperature of approximately 38° C (100° F). The jar shall then be shaken vigorously for 30 seconds. After shaking, the asphalt coating on the sand shall be observed under a constant, strong light. Complete coating of the sand is required.

440

- (x) Stripping tests for bituminous mixtures using asphalt cements and liquid asphalts, with or without additives, shall be performed as follows:

Test 1

450

A sample of produced mixture, 500 grams minimum, shall be obtained for testing. The size of test specimen and the amount of distilled water shall be:

460

Size of Aggregate	Approximate Minimum Weight of Test Specimen	Amount of Distilled Water
Sand	100 g	400 ml
12	100 g	400 ml
11	150 g	600 ml
9	200 g	600 ml

Place the specimen in the boiling distilled water and stir with a glass rod at the rate of 1 revolution per second for 3 minutes. The aggregate shall retain a minimum of 90 percent of its bituminous film compared with the remainder of the sample, upon completion of this procedure.

Test 2

470

Approximately 500 g of produced mixture shall be heated to 121p C (250p F) in a laboratory oven for 2 hours; stirred and cooled to 92.5p C (200p F). Then a portion of the mix shall be placed in boiling distilled water, quantity of mix and quantity of boiling water shall be as specified in Test 1, and stirred with a glass rod at the rate of one revolution per second for 3 minutes. The aggregate shall retain a minimum of 90 percent of its bituminous film compared with the remainder of the sample, upon completion of this procedure.

480

Note: The purpose of these tests is to determine the relative compatibility of the aggregate and bitumen, and to detect tendency of Asphalt Emulsions to reemulsify. Test 2 may be performed as a method of determining whether compatibility can be achieved, Test 1 having given unsatisfactory results.

(y) Penetrating Ability of AE-PL.

1. Apparatus and Equipment:

490

a. Sand mixture:

- (1) Dry Standard Ottawa Sand
(AASHTO T 106) 90 parts
- (2) Dry Reference Limestone Dust, portion passing 300 mm (#50) sieve only. Reference Limestone Dust used by the Department is Limestone Calcium Carbonate manufactured by France Stone Co. The Department will furnish approximately 2.3 kg (5 lb) of Reference Limestone Dust upon request 10 parts
- (3) Water 3 parts

500

b. Container, 170 g (6 oz) ointment tin

- c. Ruler or other measuring device
- d. Timing device readable in seconds

510

- e. Compacting Device. Rimac Spring Tester or other device suitable for compacting sand by applying a 140 kPa (20 psi) load. The compacting device shall include an adapter consisting of 2 metal discs slightly smaller in diameter than a 170 g (6 oz) ointment tin separated by a spacer 25 mm (1 in.) to 50 mm (2 in.). The 65 mm (2.54 in.) diameter discs used in determining weight of coating in AASHTO T 65 or ASTM A 90 are satisfactory.

- f. Small, square ended spatula or putty knife

520

2. Procedure:

Thoroughly mix Standard Ottawa Sand, Reference Limestone Dust, and water. Weigh 190 ± 1 g of sand mixture into a 170 g (6 oz) ointment tin. Level surface of sand with a spatula. Place the compacting adapter on the sand surface and slowly, over a period of about 5 seconds, compact the sand until the 140 kPa (20 psi) load is achieved, which is approximately 45 kg (100 lb) on the Rimac Spring Tester. Remove the compacting device, avoiding disturbance to the sand surface. Quickly pour 12 g of the emulsion from a height of about 100 mm (4 in.) onto top of sand mixture. Start timer at start of pour. Stop timer when all emulsion penetrates into sand mixture. Delay 2 minutes, then remove sand and mixture from one side of ointment tin, about 1/2 of mixture. Measure to determine average depth of penetration into sand mixture. Penetration time shall be 100 seconds or less; penetration depth shall be 6 mm (1/4 in.) or more.

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- (z) Flow Test for Asphalt for Coating Corrugated
Metal Pipe AASHTO M 190

540

- (aa) Shock Test for Asphalt for Coating Corrugated
Metal Pipe AASHTO M 190

- (bb) Viscosity Determinations of Unfilled
Asphalt Using the Brookfield Thermosel
Apparatus ASTM D 4402

- (cc) Determining the Rheological Properties
of Asphalt Binder Using a Dynamic
Shear Rheometer AASHTO TP5

550

- (dd) Accelerated Aging of Asphalt Binder
Using a Pressurized Aging Vessel AASHTO PP1

- (ee) Determining the Flexural Creep Stiffness
of Asphalt Binder Using the Bending
Beam Rheometer AASHTO TP1

902.10 Application Temperatures. Bituminous materials for the several applications indicated in the specifications shall be applied at temperatures not to exceed those shown in the table.

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570

580

Type and Grade of Material	Maximum Application Temperature °C (°F)	
	Spray	Mix
RC-70, RCA-70	66 (150)	---
RC-250, RCA-250	80 (175)	66 (150)
RC-800, RCA-800	107 (225)	93 (200)
RC-3000, RCA-3000	135 (275)	107 (225)
MC-70, MCA-70	66 (150)	---
MC-250, MCA-250	107 (225)	93 (200)
MC-800, MCA-800	121 (250)	107 (225)
MC-3000, MCA-3000	135 (275)	121 (250)
SC-70, SCA-70	93 (200)	---
CS-250, SCA-250	107 (225)	107 (225)
SC-800-3000, SCA-800-3000	121 (250)	121 (250)
All Emulsions	71 (160)	82 (180)
All Penetration and Viscosity Grades of Asphalt Cement	177 (350)	163 (325)

SECTION 903—CLASSIFICATION OF SOILS

903.01 Definitions. All of the soils shall be tested and classified in accordance with AASHTO M 145, and in accordance with the grain-size classification procedure as follows:

Soil Classification	Definition
Boulders	Retained on 75 mm (3 in) sieve
Gravel	75 mm (3 in) to 2.0 mm (No. 10) sieve
Coarse Sand	2.00 mm (No. 10) to 425 µm (No. 40) sieve
Fine Sand	425 µm (No. 40) to 75 µm (No. 200) sieve
Silt	0.075 to 0.002 mm
Clay	Smaller than 0.002 mm
Colloids	Smaller than 0.001 mm

903.02 Soils Having 0 to 19 Percent Retained on 2.00 mm (No. 10) Sieve. These soils shall be classified as follows:

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Classification	Percent Sand and Gravel	Percent Silt	Percent Clay
Sand	80 - 100	0 - 20	0 - 20
Sandy Loam	50 - 80	0 - 50	0 - 20
Loam	30 - 50	30 - 50	0 - 20
Silty Loam	0 - 50	50 - 80	0 - 20
Silt	0 - 20	80 - 100	0 - 20
Sandy Clay Loam	50 - 80	0 - 30	20 - 30
Clay Loam	20 - 50	20 - 50	20 - 30
Silty Clay Loam	0 - 30	50 - 80	20 - 30
Sandy Clay	50 - 70	0 - 20	30 - 50
Silty Clay	0 - 20	50 - 70	30 - 50
Clay	0 - 50	0 - 50	30 - 100

30

903.03 Soils Having 20 Percent or More Retained on 2.00 mm (No. 10) Sieve and More Than 20 Percent Passing 75 μ m (No. 200) Sieve. These soils shall be classified in accordance with 903.02, followed by a term describing the relative amount of gravel as follows:

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20 to 35 percent:

"with some gravel"

36 to 50 percent:

"and gravel"

903.04 Soils Having 20 Percent or More Retained on 2.00 mm (No. 10) Sieve and Less Than 20 Percent Passing 75 μ m (No. 200) Sieve. These soils shall be classified as follows:

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Classification	Percent Gravel	Percent Sand	Percent Silt	Percent Clay
Gravel	85 - 100	0 - 15	0 - 15	0 - 15
Sandy Gravel	40 - 85	15 - 40	0 - 20	0 - 20
Gravelly Sand	20 - 40	40 - 80	0 - 20	0 - 20
Sand & Gravel	20 - 50	20 - 50	0 - 20	0 - 20

If the gradation of a given sample is not in exact accordance with the requirements for a given classification, it shall be placed in the classification to which it comes the closest.

903.05 Organic Soils. The following classification system shall be used for organic soils in accordance with AASHTO T 267.

60

Classification	Percentage
With Trace Organic Matter	1 to 6
With Little Organic Matter	7 to 12
With Some Organic Matter	13 to 18
Organic Soil (A-8)	19 - 30
Peat (A-8)	More than 30

903.06 Marly Soils. The following classification system shall be used for marly soils with calcium and magnesium carbonate content.

70

Classification	Percentage
With Trace Marl	1 to 9
With Little Marl	10 to 17
With Some Marl	18 to 25
Marly Soil (A-8)	26 to 40
Marl (A-8)	More than 40

SECTION 904—AGGREGATES

904.01 Fine Aggregates. Fine aggregates shall consist of natural sand or manufactured sand produced by crushing limestone, dolomite, steel furnace (SF) slag, air cooled blast furnace (BF) slag, granulated blast furnace (GBF), or wet bottom boiler slag. At time of use they shall be free from lumps or crusts of hardened or frozen materials and shall be in accordance with the specifications as set out herein.

10

No source will be considered for acceptance of material until a preliminary investigation has been made. As part of this investigation, samples will be taken and tests conducted to determine the quality of the aggregates.

(a) For Portland Cement Concrete. Fine aggregate for use in portland cement concrete pavement or bridge decks shall be natural sand. Fine aggregate for other portland cement concrete shall be natural sand or crushed limestone,

20 dolomite, or air-cooled blast furnace slag. The gradations shall be in accordance with 904.01(g) and shall be well graded from coarse to fine.

30 The sand shall have not more than 3% of organic impurities. When subjected to the colorimetric test for organic impurities and a color darker than the standard is produced, it shall be tested for effect of organic impurities on strength of mortar in accordance with AASHTO T 71. If the relative strength at 7 days is less than 95 percent it shall be rejected. When the sand is subjected to 5 cycles of the sodium sulphate soundness test or 25 cycles of the brine freeze-and-thaw soundness test, the weighted loss shall not exceed 10.0 percent by weight or 12.0 percent by weight, respectively. Fine aggregates may, at the option of the Engineer, be subjected to 50 cycles of freezing and thawing in accordance with AASHTO T 103, Procedure A, and may be accepted, provided they do not have a loss greater than specified for sodium sulfate soundness.

40 **(b) For Bituminous Mixtures.** Fine aggregates for use in bituminous mixtures shall consist of natural sand or manufactured sand having similar characteristics, except SF slag sand will only be permitted when the coarse aggregate is SF slag. A combination of natural sand and manufactured sand will be permitted when approved; however, not more than 20 percent of the fine aggregate used in bituminous surface mixtures shall be crushed limestone sand. Windblown sand or similar sands will not be acceptable for blending. The fine aggregate, including blended fine aggregate, used in bituminous sand surface mixtures shall have a Florida Bearing Value of not less than 30. The fine aggregate, including blended fine aggregate, used in bituminous sand surface mixtures shall have an acid insoluble content of not less than 40 percent, except when using ABF or GBF slag sand, the acid insoluble content shall not be less than 25 percent. Fine aggregates shall be in accordance with 904.01(a) for soundness. The mass (weight) adjustment in accordance with 904.02(a) will be applied to fine aggregate only when manufactured from SF slag.

50 **(c) For Pneumatic Placement.** Fine aggregate for use in pneumatic placement shall be natural sand suitable for use with a pneumatic sand cement gun. It shall be in accordance with the requirements for organic impurities and soundness as set out in 904.01(a). It may be in accordance with 904.01(g), size No. 15, or the following gradation:

Sieve Size No.	4.75 mm (4)	2.36 mm (8)	600 µm (30)	300 µm (50)	150 µm (100)
Percent Passing	100	85-95	50-65	15-25	0-10

60 **(d) For Mortar.** Fine aggregate for mortar shall consist of natural sand. It shall be graded uniformly from coarse to fine and shall be in accordance with gradation requirements of 904.01(g) for size No. 15. It shall be in accordance with 904.01(a) for organic impurities and soundness.

(e) Mineral Filler. Mineral filler shall consist of dust produced by crushing stone, portland cement, fly ash, or other inert mineral matter having similar characteristics for use in hot asphalt concrete. It shall be in accordance with the gradation requirements of 904.01(g) for size No. 16. Fly ash shall have been collected by means of an electrostatic precipitation method and shall not contain free carbon in excess of 10 percent by mass (weight). The sieve analysis of mineral filler shall be conducted in accordance with AASHTO T 37 except as noted in 904.03.

70

(f) Snow and Ice Abrasives. Snow and ice abrasives shall be steel furnace slag, air cooled blast furnace slag, granulated blast furnace slag, boiler slag, natural sand, crushed stone sand, or cinders. The abrasives shall pass the following gradation requirements:

Passing the 9.5 mm (3/8 in.) sieve 100%
 Passing the 300 μ m (No. 50) sieve 0-30%
 Passing the 75 μ m (No. 200) sieve 0-7%

When steel slag is used as snow and ice abrasives, and payment is on a tonnage basis, the pay quantity shall be adjusted in accordance with 904.02(a).

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(g) Sizes of Fine Aggregates.

Sieve Sizes	SIZES (PERCENTS PASSING)			
	23	24	15	16
9.5 mm (3/8 in.)	100	100		
4.75 mm (No. 4)	95-100	95-100		
3.35 mm (No. 6)	—	—	100	
2.36 mm (No. 8)	80-100	70-100	90-100	
1.18 mm (No. 16)	50-85	40-80	—	
600 μ m (No. 30)	25-60	20-60	50-75	100
300 μ m (No. 50)	5-30	7-40	15-40	—
180 μ m (No. 80)	—	—	—	95-100
150 μ m (No. 100)	0-10	1-20	0-10	—
75 μ m (No. 200)	0-3	0-6	0-3	65-100

90

Note: The fine aggregate shall have not more than 45 percent retained between any 2 consecutive sieves.

(h) Sampling and Testing. Sampling and testing shall be conducted in accordance with the following AASHTO and ITMs:

100

	Acid Insoluble Content	ITM 202
	*Amount of Material Finer than	
	75 μ m (No. 200) sieve	AASHTO T 11
	Brine Freeze-and-Thaw Soundness	ITM 209
	Control Procedures for Classification of Aggregates	ITM 203
	Florida Bearing Value	ITM 201
110	Mortar Strength	AASHTO T 71
	Organic Impurities	AASHTO T 21
	*Sampling Aggregates	AASHTO T 2
	Sampling Stockpiled Aggregates	ITM 207
	*Sieve Analysis of Aggregate	AASHTO T 27
	*Sieve Analysis of Mineral Filler	AASHTO T 37
	*Soundness	AASHTO T 103, T 104
	*Except as noted in 904.03.	

904.02 Coarse Aggregates.

120

(a) **General Requirements.** Coarse aggregates shall consist of crushed limestone or dolomite; crushed or uncrushed gravel; crushed steel furnace (SF) slag or air cooled blast furnace (BF) slag; or sandstone. When dolomite coarse aggregates are used in accordance with 401.02, the material furnished shall be carbonate rock containing at least 10.3 percent elemental magnesium when tested as set out in ITM No. 205. Coarse aggregates shall not contain more than 15 percent flat or elongated pieces and shall not contain particles with an adherent coating. A flat or elongated piece is defined as one having a length in excess of 4 times its width. Determination of the width will be made by hand manipulating the pieces through a standard sieve. The smallest sieve opening through which the piece will pass will be considered the width of the particle. The percentage of these particles will be determined by dividing the weight of flat or elongated particles retained on the 4.75 mm (No. 4) sieve by the total weight of material retained on the 4.75 mm (No. 4) sieve.

130

Sandstone may be used only in bituminous surface mixtures. Sandstone for this use shall meet the Class B quality requirements and shall consist of a minimum of 50 percent quartz sand grains cemented with calcium carbonate.

140

Steel furnace (SF) slag may be used in compacted aggregate shoulders in accordance with 303, in surface mixtures for Hot Asphalt Emulsion Pavement in accordance with 402, in surface mixtures for Hot Asphalt Concrete Pavement in accordance with 403, in surface mixtures for Bituminous Coated Aggregate Pavement in accordance with 404, as dumped riprap or revetment riprap in accordance with 616.02(a) or 616.02(b) respectively, and for snow and ice abrasives in accordance with 904.01(f).

When slag is furnished as an alternate to natural aggregate, and payment is on a mass (weight) basis, adjustments shall be made to compensate for the difference in specific gravity of the slag compared to natural aggregate. The following typical values for specific gravity will be used: natural aggregate both fine and coarse, 2.6; air cooled

150

blast furnace (ABF) slag coarse aggregate, 2.3; air cooled blast furnace (ABF) slag fine aggregate, 2.6; granulated blast furnace (GBF) slag fine aggregate, 2.1; and steel furnace (SF) slag both fine and coarse, 3.2. The adjustment shall not apply to aggregates or bituminous mixture used for approaches or patching.

When slag is furnished as an ingredient of a bituminous mixture, the adjustment shall be applied as follows:

160

1. Determine the amount of natural aggregate in the mixture using the following formula:

$$A = T(1 - \%B)$$

A = Megagrams (tons) of natural aggregate in the mixture.

T = Pay item quantity in megagrams (tons) for the specified mixture.

%B = Percent bitumen as decimal from the job mix formula.

%FA = Percent passing 4.75 mm (No. 4) sieve as a decimal from the job mix formula.

%CA = Percent retained on 4.75 mm (No. 4) sieve as a decimal from the job mix formula.

170

2. Determine the amount of slag required for coarse aggregate (CAS) by the following formula:

$$CAS = A(\%CA) (\text{SpGr Slag}/2.6)$$

3. Determine the amount of slag required for fine aggregate (FAS) by the following formula:

$$FAS = A(\%FA) (\text{SpGr Slag}/2.6)$$

180

4. Determine the adjusted quantity in megagrams (tons) (TAS) by the following formula:

$$TAS = T(\%B) + CAS + \text{Weight of fine aggregate used}$$

5. Adjust the design lay in kilograms per square meter (lb per sq yd) by the following formula:

$$\text{Adjusted lay} = (\text{Design Lay}) (TAS/T)$$

190

6. Determine adjusted pay quantity by the following formula:

$$\text{Adjusted pay quantity} = (\text{accepted megagrams [tons]}) (T/TAS)$$

200

When slag is furnished as an aggregate, the approximate quantity of megagrams (tons) to be supplied will be determined by multiplying the pay item quantity of megagrams (tons) by the specific gravity of slag divided by 2.6. The adjusted pay quantities will be determined by multiplying the accepted quantity of megagrams (tons) by 2.6 divided by the specific gravity of the slag.

210

Crushed gravel shall have a minimum of one angular fractured face, such as a broken surface, which was caused mechanically or naturally. Natural fractures and mechanical fractures shall be the same in texture and effect. An acceptable fractured area shall have at least 25 percent of the largest cross sectional area of the particle as specified in ITM 204.

Riprap aggregate shall consist of sound stone, stone masonry, steel slag for dumped riprap or revetment riprap only, or other approved material, free from structural defects and of approved quality. Stone containing shale, unsound sandstone, or any other material which will disintegrate readily, shall not be used.

220

Recycled portland cement concrete may be used in compacted aggregate base in accordance with 303. It may be used in subbase in accordance with 904.04. Recycled portland cement concrete shall be in accordance with quality and gradation requirements. If recycled portland cement concrete pavement is used from within the project limits, only the gradation requirements will apply.

No source will be considered for acceptance of material until a preliminary investigation has been made. As part of this investigation, samples will be obtained and tests conducted to determine the classification of the aggregates. There are 2 types of samples required for the preliminary investigation; namely, ledge samples for crushed stone sources and production samples for crushed stone, gravel, and slag sources.

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Ledge samples will be obtained from the bedrock units as they naturally occur in the proposed working face of the quarry. These units will be identified by their differences in color, texture, geological formation, etc.

Production samples will be obtained from stockpiles of finished materials.

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The coarse aggregate shall comply with the quality requirements and the additional requirements as shown in the following table. However, coarse aggregate may be rejected based on previous performance service records. Class A is defined as the highest classification and class F the lowest. Blending of material for compliance with gradation or crushed particle requirements may be permitted when requested in writing. Blending a material which does not meet the quality or deleterious requirements with a better material to upgrade the end product will not be permitted.

Classification of finished products offered for use will be made in accordance with ITM 203.

(b) Classification of Aggregates.

Characteristic Classes	AP	A	B	C	D	E	F
Quality Requirements							
Freeze-and-Thaw Beam Expansion, % Max. (Note 9)060						
Los Angeles Abrasion, %, Max. (Note 1) . . .	40.0	40.0	40.0	45.0	45.0	50.0	
Sodium Sulfate Soundness, %, Max. (Note 2	12.0	12.0	12.0	16.0	16.0	20.0	25.0
Brine Freeze-and-Thaw Soundness, % Max. (Note 8)	30	30	30	40	40	50	60
Absorption, %, Max. (Note 3)	5.0	5.0	5.0	5.0			
Additional Requirements							
Deleterious, %, Max.							
Clay Lumps and Friable Particles	0.2	0.2	0.2	0.2	0.2		
Non-Durable (Note 4)	4.0	4.0	4.0	6.0	8.0		
Coke				(See	Note 7)		
Iron				(See	Note 7)		
Chert (Note 5)	3.0	3.0	5.0	8.0	10.0		
Mass Per Cubic Meter for Slag, kg, Weight Per Cubic Foot for Slag, (lbs), Min.	1200 (75.0)	1200 (75.0)	1200 (75.0)	1120 (70.0)	1120 (70.0)	1120 (70.0)	
Crushed Particles, %, Min. (Note 6)							
Bituminous Seal Coats		70.0	70.0				
Compacted Aggregates		20.0	20.0	20.0	20.0		

- NOTES:
- Los Angeles abrasion requirements shall not apply to blast furnace slag.
 - Aggregates may, at the option of the Engineer, be subjected to 50 cycles of freezing and thawing in accordance with AASHTO T 103, Procedure A, and may be accepted, provided they do not have a loss greater than specified for Sodium Sulfate Soundness.
 - Absorption requirements apply only to aggregates used in portland cement concrete and bituminous mixtures except they shall not apply to blast furnace slag. When crushed stone coarse aggregates from Category I sources consist of production from ledges whose absorptions differ by more than 2 percentage points, the absorption test will be performed every 3 months on each size of material proposed for use in portland cement concrete or bituminous mixtures. When a subsequent 3 month test does not agree within one percentage point of the previous test for a particular size of material, an absorption test will be performed on acceptance samples at a frequency sufficient to facilitate mix design revision and documentation. If variations in absorption preclude satisfactory production of portland cement concrete or bituminous mixtures, independent stockpiles of materials will be sampled, tested, and approved prior to use.
 - Non-durable particles include soft particles as determined by ITM 206 and other particles which are structurally weak, such as soft sandstone, shale, limonite concretions, coal, weathered schist, cemented gravel, ocher, shells, wood, or other objectionable material. Determination of non-durable particles shall be made from the total weight of material retained on the 9.5 mm (3/8 in.) sieve. Scratch Hardness Test shall not apply to crushed stone coarse aggregate.
 - The bulk specific gravity of chert shall be based on the saturated surface dry condition. The amount of chert less than 2.45 bulk specific gravity, shall be determined on the total weight of material retained on the 9.5 mm (3/8 in.) sieve for sizes 1 through 8, 53, and 91 and on the total mass (weight) of material retained on the 4.75 mm (No. 4) sieve for sizes 9 and 11.
 - Crushed particle requirements will apply to gravel coarse aggregates used in bituminous mixtures, compacted aggregates, and bituminous seal coats except seal coats used on shoulders. Crushed particle requirements for bituminous mixtures are set out in 401.02. Determination of crushed particles shall be made on material retained on the 4.75 mm (No. 4) sieve.
 - Air-cooled blast furnace slag and steel slag coarse aggregate shall be free of objectionable amounts of coke and iron.

- Brine freeze-and-thaw soundness requirements are subject to the conditions stated in note 2.

9. Freeze-and-thaw beam expansion shall be tested and retested in accordance with ITM 203.

904.02

AGGREGATES

(c) Blank.

310

(d) Blank.

(e) Sizes of Coarse Aggregates.

Sieve Sizes	COARSE AGGREGATE SIZES (PERCENTS PASSING)									
	1	2	5	8	9	11	12	53 ⁽¹⁾	73 ⁽¹⁾	91
100 mm (4 in.)	100									
90 mm (3 1/2 in.)	90-100									
63 mm (2 1/2 in.)	25-60	100								
50 mm (2 in.)	—	95-100								
37.5 mm (1 1/2 in.)	0-15	—	100					100		
25 mm (1 in.)	—	0-20	85-98	100				80-100	100	100
19 mm (3/4 in.)	0-5	0-5	60-85	75-95	100		—	70-90	90-100	—
12.5 mm (1/2 in.)	—	0-2	30-60	40-70	60-85	100	100	55-80	60-90	—
9.5 mm (3/8 in.)	—	—	15-45	20-50	30-60	75-95	95-100	—	—	—
4.75 mm (No. 4)	—	—	0-15	0-15	0-15	10-30	50-80	35-60	35-60	—
2.36 mm (No. 8)	—	—	0-10	0-10	0-10	0-10	0-35	25-50	—	—
600 µm (No. 30)	—	—	—	—	—	—	0-4	12-30	12-30	—
75 µm (No. 200)(2)	—	—	—	—	—	—	—	5.0-10.0	5.0-10.0	—
Decant Conc ⁽³⁾	—	—	0-1.5	0-1.5	0-1.5	0-1.5	—	—	—	0-1.5
Other	0-1.0	0-2.5	0-2.5	0-3.0	0-2.5	0-2.5	0-2.0	—	—	0-2.5

- NOTES:
1. The fraction passing the 75 µm (No. 200) sieve shall not exceed 2/3 the fraction passing the 600 µm (No. 30) sieve. The liquid limit shall not exceed 25(35 if slag) and the plasticity index shall not exceed 5. The liquid limit shall be determined in accordance with AASHTO T 89 and the plasticity index in accordance with AASHTO T 90. Unless otherwise specified, when these materials are not to be surfaced or sealed under the contract, the amount passing the 75 µm (No. 200) sieve shall be 5 to 12 percent and the plasticity index shall not exceed 7.
 2. Includes the total amount passing the 75 µm (No. 200) sieve as determined by AASHTO T 11 and T 27.
 3. When the material is stone or slag, the decant may be 0 to 2.5.

340 (f) Sampling and Testing. Sampling and testing shall be in accordance with the following AASHTO and ITMs:

	Abrasion	AASHTO T 96
	*Amount of Material finer than	
	No. 200 (75 μ m) Sieve	AASHTO T 11
	Brine Freeze-and-Thaw Soundness	ITM 209
	Clay Lumps and Friable Particles	AASHTO T 112
	Control Procedures for Classification of Aggregates	ITM 203
	Crushed Particles	ITM 204
350	Dolomite Aggregates	ITM 205
	Freeze-and-Thaw Beam Expansion	ITM 203
	*Lightweight Pieces in Aggregates	AASHTO T 113
	*Sampling Aggregates	AASHTO T 2
	Sampling Stockpiled Aggregates	ITM 207
	Scratch Hardness	ITM 206
	*Sieve Analysis	AASHTO T 27
	*Soundness	AASHTO T 103, T 104
	*Specific Gravity and Absorption	AASHTO T 85
	Unit Weight and Voids in Aggregates	AASHTO T 19
360	*Except as noted in 904.03.	

904.03 Exceptions to AASHTO Standard Methods.

(a) Exceptions to AASHTO T 2. Stockpile sampling shall be done in accordance with ITM 207, unless otherwise permitted.

(b) Exceptions to AASHTO T 11, T 27, and T 37.

- 370**
1. When tests are performed in the field where ovens are not available, test samples may be dried in suitable containers over open flame or electric hot plates with sufficient stirring to prevent overheating, then cooled to constant mass (weight).
 2. The scales used for performing field tests of fine aggregates shall be graduated in increments not greater than one gram.

(c) Exceptions to AASHTO T 27 for Coarse Aggregates. The size of test samples for coarse aggregate shall be as follows:

380	Aggregate Size	Minimum Mass (Weight) of Test Sample
	No. 1	68-90.7 kg (150-200 lb)
	No. 2	11.3 kg (25 lb)
	No. 5, 8, 53, and 91	(6-8 kg)
	No. 9 and 11	(4-6 kg)
	*Subbase	(4-6 kg)

*B Borrow (4-6 kg)

*If subbase or B borrow is fine aggregate, at least 90 percent passing the 4.75 mm (No. 4) sieve, the test sample shall be approximately 500 grams.

(d) Blank.

(e) Exceptions to AASHTO T 103 and T 104.

1. Counting the number of individual particles coarser than the 19.0 mm (3/4 in.) sieve will not be required.
2. For testing ledge rock, the ledge samples shall be crushed to obtain test samples for the designated increments passing the 37.5 mm (1 1/2 in.) sieve and retained on the 4.75 mm (No. 4) sieve. The factors used to calculate the weighted average loss are 30 percent, 40 percent and 30 percent of the 37.5 mm (1 1/2 in.) - 19.0 mm (3/4 in.), 19.0 mm (3/4 in.) - 9.5 mm (3/8), and 9.5 mm (3/8) - 4.75 mm (No. 4) increments, respectively.
3. In the case of ledge rock, modify sections 3.3 and 6.2 of T 103 and T 104 respectively. When the sample received is deficient in material of a component size of any test portion, that material will be supplemented with the available component size to provide the test portion.
4. Modify section 8 of T 103 and section 10 of T 104. For materials designated as a coarse aggregate, the weighted loss will be calculated considering the material retained on the 4.75 mm (No. 4) sieve as 100 percent of the sample, and only the total weighted loss reported. In AASHTO T 104 sections 10.1.3.2 and 10.1.3.3 shall not apply, and unless otherwise noted only new solution will be used.

(f) Exceptions to AASHTO T 85. The in-water mass shall be determined following the 15 hour soaking period prior to determining the saturated surface dry mass (weight).

904.04 Subbase Materials.

(a) Gradation Requirements for Stone, Gravel, Air-Cooled Blast Furnace Slag, and Recycled Portland Cement Concrete. The table of gradation requirements is shown on the next page.

(b) Gradation Requirements for Granulated Slag Subbase.

Sieve Size	Percent Passing
75 mm (3 in.)	95-100
25 mm (1 in.)	90-100
75 μ m (No. 200)	0-10.0

The maximum size shall be such that can be incorporated in a 150 mm (6 in.) layer.

440

(c) Quality Requirements.

1. If the material is 50 mm (2 in.), 37.5 mm (1 1/2 in.), or 25 mm (1 in.) top size as set out in 903.04(a), the coarse aggregate portion shall be in accordance with quality requirements for class A, B, C, or D in accordance with 904.02(b). The fine aggregate portion shall be in accordance with the quality requirements of 904.01(a).
2. If the material is 13 mm (1/2 in.) top size as set out in 904.04(a), it shall be in accordance with requirement 1 of 904.04(c).
3. If the material is 4.75 mm (No. 4) or 600 μ m (No. 30) top size as set out in 904.04(a), it shall be in accordance with 904.01(a).

450

GRADATION REQUIREMENTS FOR STONE, GRAVEL, AND AIR-COOLED BLAST FURNACE SLAG

Approximate Permissible Top Size	Total Percent Passing Sieves Having Square Openings									
	63 mm (2 1/2")	50 mm (2")	37.5 mm (1 1/2")	25.0 mm (1")	19.0 mm (3/4")	12.5 mm (1/2")	4.75 mm (No. 4)	2.36 mm (No. 8)	600 µm (No. 30)	75 µm (No. 200)
50 mm (2 in.)	100	95-100	75-98	60-90	50-85	40-80	25-60	15-45	8-30	3.0-8.0
37.5 mm (1 1/2 in.)		100	95-100	75-98	60-90	45-85	25-65	15-50	8-30	3.0-8.0
25 mm (1 in.)			100	90-100	75-98	60-90	30-70	20-55	8-30	3.0-8.0
12.5 mm (1/2 in.)			100	---	---	90-100	50-80	30-70	10-40	3.0-8.0
4.75 mm (No. 4)						100	95-100	80-95	20-55	3.0-8.0
600 µm (No. 30)						100	---	---	85-100	0-7.0

Notes: In addition to other requirements, the amount passing the 75 µm (No. 200) sieve shall not exceed 2/3 the amount passing the 600 µm (No. 30) sieve. The use of 13 mm (1/2 in.), 4.75 mm (No. 4), and 600 µm (No. 30) top size material will not be permitted as subbase for flexible pavement, but 13 mm (1/2 in.) and 4.75 mm (No. 4) top size material will be permitted as subbase under shoulders. The use of 600 µm (No. 30) top size material will be permitted under portland cement concrete pavement or base only when specifically provided for in the special provisions. If a method of draining the subbasematerial in place is not provided, the amount passing the 75 µm (No. 200) sieve shall be (1) 7-14 percent for 50 mm (2 in.), 37.5 mm (1 1/2 in.), and 25 mm (1 in.) top size, (2) 6-12 percent for 13 mm (1/2 in.) top size, and (3) 5-10 percent for 4.75 mm (No. 4) top size. See 304.02 for permissible minor variations in gradation.